MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

EEL 3146 – ELECTRIC POWER UTILIZATION AND INSTALLATION

(LE)

09 MARCH 2019
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 10 pages including cover page with 5 Questions only.
2. Answer ALL questions. All questions carry equal marks and the distributions of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

a) Code of Practice 72 included in MS1979:2007 is given below. Explain step by step on how you test earth resistance.

[12 marks]

4.11.4 COP 72, Maintenance of earthing system

The earthing system of electrical installations shall be effectively maintained and checked annually.

b) Table below shows the requirement for RCCB in electrical installation. Explain why there is a need to have three different sensitivity ratings.

Requirements For the Use of Residual Current Circuit Breakers (Sensitivity) Based on Regulation 36, Electricity Regulations 1994

No.	Installation Type	Residual Current Device Sensitivity (Maximum)	Requirement
1.	Overall Wiring (Single Phase or Three Phase)	100mA (0.1A)	Mandatory
2.	Final Circuit for Power (13A socket outlets)	30mA (0.03A)	Mandatory
3.	Wet places (toilets and wet kitchens) /Water heater circuits	10mA (0.01A)	Mandatory

[4 marks]

c) Sketch a circuit diagram for wiring installation for two switch socket outlets in radial connection.

[4 marks]

Continued...

Question 2

a) A 250 Ton train with 10% rotational inertia effect is started with uniform acceleration on level track. Determine the specific energy consumption if the journey is to be made according to a simplified trapezoidal speed-time curve as shown in Figure Q2. The distance between stations is 2.5 km, efficiency of motor 90% and track resistance 5 kg/ton.

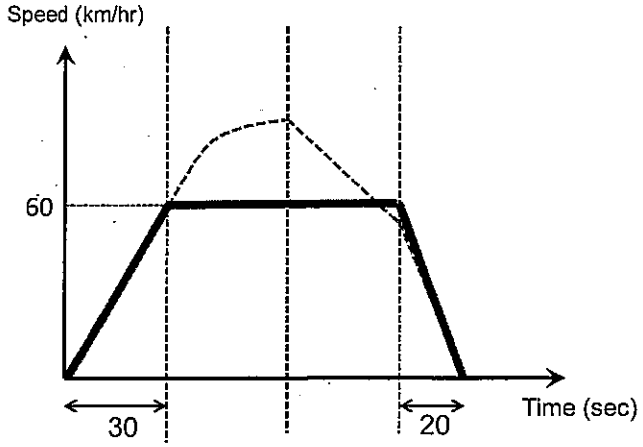

Figure Q2

[12 Marks]

b) Explain with a diagram how current collection is executed by a train with a third rail system.

[8 Marks]

Continued...

Question 3

Figure Q3 shows a circuit for a fixed equipment (supply 230 V). The circuit is protected using a 20A Type C MCB. Calculate the suitable size for the circuit protective conductor (CPC). Verify your answer with the adiabatic equation. Expected disconnection time is 5 s.

Live cable – 4.0 mm^2 single core PVC non-sheathed cables enclosed in PVC conduit
Impedance external to the installation is 0.5 Ω

The time/current characteristic of MCB and value for K for adiabatic equation can be found in a table given in Appendix A and B respectively.

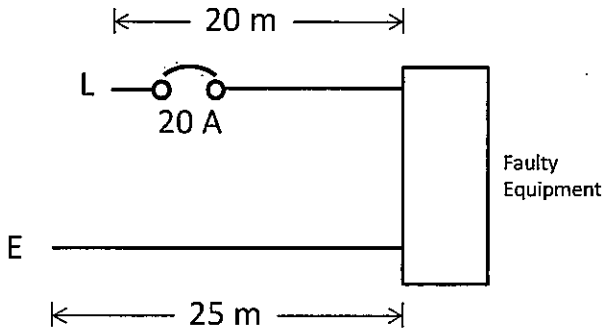

Figure Q3

Table Q3 - Resistance per meter of copper conductors at 20°C for calculation of R1 + R2

Conductor cross-sectional area (mm^2)	*Resistance per meter run (m ohms / m)*
1.0	18.1
1.5	12.10
2.5	7.41
4.0	4.61
6.0	3.08
10.0	1.83
16.0	1.15
25.0	0.727
Note that to allow for the increase in resistance with increased temperature under fault conditions the values of {Table 1} must be multiplied by 1.2 for p.v.c. insulated cables	

[20 Marks]

Continued...

Question 4

Florescent lamp type T5 was selected for an industry office space. Electrical data for the lamps is given in Table Q4. The dimension of the office is 25 m (length) x 20 m (width) x 3 m (height).

Table Q4

Electrical data

Nominal voltage	220 V
Rated lamp efficacy (HF data 25 °C)	86 lm/W
Rated wattage	27.90 W
Nominal wattage	28.00 W

a) Determine the minimum illuminance for this office space. Refer to table in Appendix A.
[4 Marks]

b) Determine the number of lamps required to obtain the minimum illuminance. Assuming the maintenance factor is 0.7 and that coefficient of utilization is 0.6.
[9 Marks]

c) Explain what Color Rendering Index (CRI) is and why it is important to select lamps with high CRI?
[3 Marks]

d) List down two ways to minimize energy usage by the lightings within the office space.
[4 Marks]

Continued...

Question 5

a) State two differences between direct and indirect resistance heating.

[8 Marks]

b) Discuss two methods used to control the temperature in a resistance heater.

[4 Marks]

c) A steel factory uses a furnace to melt steels. The furnace capable to melt 20 tons steel within 4 hours. The furnace draw 9200 A from the supply to do the job at 75% efficiency. Calculate the average input power for the furnace.

Following are the parameters for furnace and steel.
Resistance of the furnace is 0.002Ω
Reactance of the furnace is 0.004Ω
Ambient temperature is 25°C
Specific heat of steel is 0.13 k Cal kg^{-1} $°C^{-1}$
Latent heat of steel is 9 k Cal/kg
Melting point of steel is 1371°C
Given 1 kW= 860 k Cal)

[8 Marks]

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Appendix A: Time/Current Characteristics for Type C Circuit Breaker

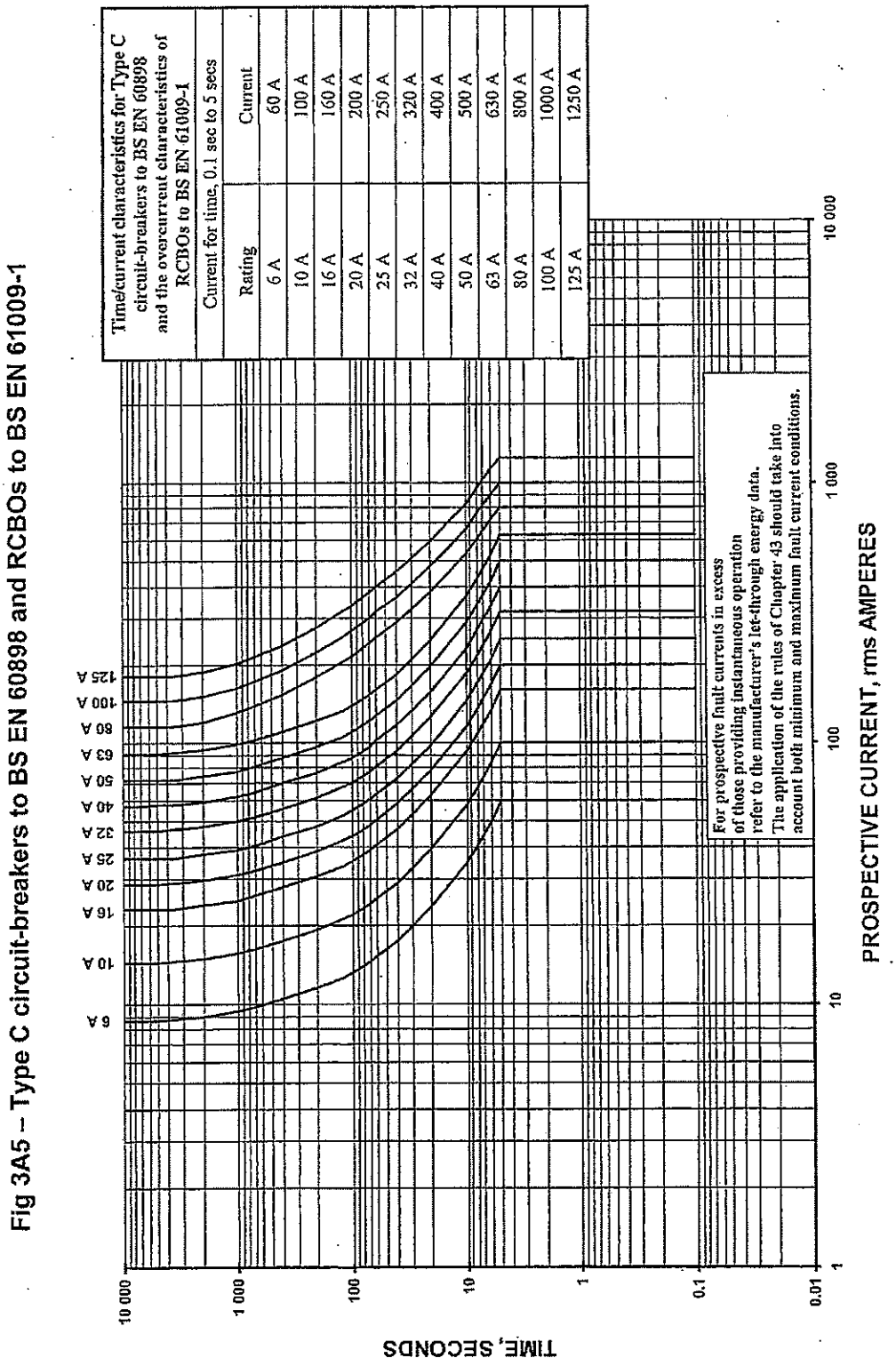

Fig 3A5 – Type C circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1

Continued…

Appendix B: Table 43.1 for Values of K

TABLE 43.1 –
Values of k for common materials, for calculation of the effects of fault current for disconnection times up to 5 seconds

Conductor insulation	Thermoplastic				Thermosetting		Mineral insulated	
	90 °C		70 °C		90 °C	60 °C	Thermoplastic sheath	Bare (unsheathed)
Conductor cross-sectional area	≤ 300 mm²	> 300 mm²	≤ 300 mm²	> 300 mm²				
Initial temperature	90 °C		70 °C		90 °C	60 °C	70 °C	105 °C
Final temperature	160 °C	140 °C	160 °C	140 °C	250 °C	200 °C	160 °C	250 °C
Copper conductor	k = 100	k = 86	k = 115	k = 103	k = 143	k = 141	k = 115	k = 135/115[a]
Aluminium conductor	k = 66	k = 57	k = 76	k = 68	k = 94	k = 93		
Tin soldered joints in copper conductors	k = 100	k = 86	k = 115	k = 103	k = 100	k = 122		

Continued...

Appendix C: MS 1525:2014

Table 10. Recommended average illuminance levels

Task and Applications	Illuminance (Lux)
a) Lighting for infrequently used area:	
- Minimum service illuminance	20
- Interior walkway and car-park	100
- Hotel bedroom	100
- Lift interior	100
- Corridor, passageways, stairs	100
- Escalator, travellator	150
- Entrance and exit	100
- Staff changing room, locker and cleaner room, cloak room, lavatories, stores.	100
- Entrance hall, lobbies, waiting room	100
- Inquiry desk	300
- Gate house	200
b) Lighting for working interiors	
- Infrequent reading and writing	200
- General offices, shops and stores, reading and writing	300 - 400
- Drawing office	300 - 400
- Restroom	150
- Restaurant, canteen, cafeteria	200
- Kitchen	150 - 300
- Lounge	150
- Bathroom	150
- Toilet	100
- Bedroom	100
- Class room, library	300 - 500
- Shop/supermarket/department store	200 - 750
- Museum and gallery	300
c) Localised lighting for exacting task	
- Proof reading	500
- Exacting drawing	1000
- Detailed and precise work	2000

Continued...

Examination Formula Sheet EEL3146

Lighting and Illumination

Inverse-square law

$$E = \frac{I}{d^2},\ E_x = \frac{I\cos^3\theta}{d^2}$$

Electric Traction

Trapezoidal Approximation

$$D = \frac{\left[2TV_m - V_m^2\left(\frac{1}{\alpha}+\frac{1}{\beta}\right)\right]}{7200}$$

Quadrilateral Approximation

$$D = \frac{\left[(V_1+V_2)T - V_1V_2\left(\frac{1}{\alpha}+\frac{1}{\beta}\right)\right]}{7200}$$

$$V_2 = \frac{V_1 - \beta_c\left(T - \frac{V_1}{\alpha}\right)}{1-\frac{\beta_c}{\beta}}$$

Net tractive effort for propulsion of train

$$F_t = 277.8M_e\alpha + Mr \pm 98MG$$

Total specific energy output

$$E_T = \frac{0.010726V_m^2}{D}\left(\frac{M_e}{M}\right) + 0.2778r\frac{D'}{D} \pm 27.25G\frac{D'}{D}\quad Whr/Ton\,km$$

Electric Heating

Heat transferred by radiation

$$Q = e\sigma A(\Delta T)^4$$

Where Q is the heat transferred by radiation, e is the emissivity of the system, σ is the constant of Stephan-Boltzmann (5.67×10^{-8} W/m^2.K^4), A is the area involved in the heat transfer by radiation, and $(\Delta T)^4$ is the difference of temperature between two systems to the fourth or higher power.

Earthing and Protection

Adiabatic equation

$$S = \frac{\sqrt{I_a^2 t}}{k}$$

End of paper